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JEE (Main)

PAPER-1 (B.E./B. TECH.)

2023

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 29 January, 2023 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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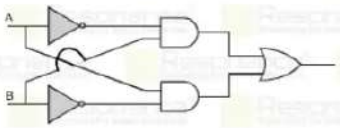
PART : PHYSICS

1. The truth table of the logic circuit shown-



(1)

A	B	Y
0	0	0
1	0	1
1	0	1
1	1	1

(2)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(3)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(4)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

Ans. (2)

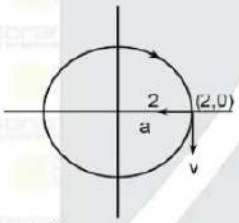
Sol. It is also called XOR gate the Boolean expression for XOR gate is $Y = A\cdot\bar{B}+\bar{A}\cdot B$

2. A particle is moving with constant speed 2 m/s clockwise in a circle of radius 2m with centre at (0,0). When it is at (2, 0) its velocity vector and acceleration vector will be :

(1) $2\hat{j},-2\hat{i}$ (2) $-2\hat{j},+3\hat{i}$ (3) $-2\hat{j},-2\hat{i}$ (4) $4\hat{j},+\hat{i}$

Ans. **(3)**

Sol.



$\vec{v} = -2\hat{j}$

$\vec{a} = -\frac{v^2}{r}\hat{i}$ $\quad r = 2$

$\vec{a} = -2\hat{i}$

3. An electromagnetic wave passes through electric and magnetic field

$E_0 \rightarrow$ amplitude of electric field

$B_0 \rightarrow$ amplitude of magnetic field

Statement-1 : It will not be affected by electric and magnetic field

Statement-2 : $E_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}}\, B_0$

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is False, Statement-2 is True.

(4) Statement-1 is True and statement-2 is False

Ans. **(4)**

Sol. Statement-1 is true and statement-2 is false

4. A satellite takes 24 hr to complete rotation about earth. If distance of satellite from centre of earth is reduced by 1/4 then find new time period :

(1) $4\sqrt{3}$ (2) $9\sqrt{3}$ (3) $\sqrt{3}$ (4) $\sqrt{3}/2$

Ans. **(2)**

Sol. $r_1 = r$

then $R_2 = r - \frac{r}{4} = \frac{3r}{4}$

$T^2 \propto r^3$

$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{r_1}{r_2}\right)^3$

$\left(\frac{24}{T_2}\right)^2 = \left(\frac{r}{3r/4}\right)^3$

$\left(\frac{24}{T_2}\right)^2 = \frac{4\times4\times4}{3\times3\times3}$

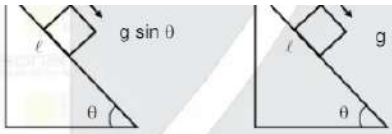
$T_2 = 9\sqrt{3}$ hr.

5. Time taken by a particle to slide down a rough incline is n times greater than to slide down a smooth identical incline of angle of incline 45° then find coefficient of friction (μ) of rough inclined plane

(1) $\mu = 1 - \frac{1}{n^2}$ (2) $\mu = 1 + \frac{1}{n^2}$ (3) $\mu = 1 - \frac{1}{n}$ (4) $\mu = n^2 - 1$

Ans. **(1)**

Sol.



$\ell = \frac{1}{2} g \sin\theta\, t_1^2 = \frac{1}{2} g (\sin\theta - \mu\cos\theta)\, t_2^2$

As $t_2 = n\, t_1$

$1 = (1 - \mu)\, n^2$

$\mu = 1 - 1/n^2$

6. If $x^2 + y^2 = a^2$, here a is radius and $(x - At)^2 + (x - t/B)^2 = a^2$. If dimension of quantity $t = [T^{-1}]$ then find the dimensions of A & B :

(1) (A) = (L^2T), (B) = $(L^{-1}T^{-1})$ (2) (A) = (LT), (B) = $(L^{-1}T^{-1})$

(3) (A) = (LT^{-1}), (B) = (L^2T) (4) (A) = (LT), (B) = $(L^{-1}T)$

Ans. **(2)**

Sol. principle of homogeneity

Dimension of $[x] = [A]\,[t]$

$[L] = [A]\,[T^{-1}]$

$[A] = [LT]$

Dimension of [x] = Dimension of $\left[\frac{t}{B}\right]$

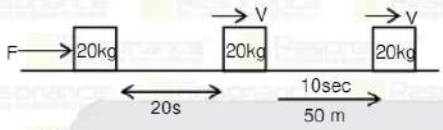
$[B] = \frac{[t]}{[x]} = \left[L^{-1}T^{-1}\right]$

7. A block of mass 20 kg at rest is acted upon by a constant horizontal force F for 20 sec and then force is removed after that it moves 50 m in 10 sec then find the value of F :

(1) 5 N (2) 10 N (3) 15 N (4) 20 N

Ans. **(1)**

Sol. F = 20 × a



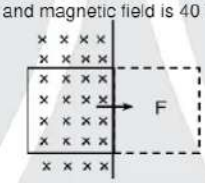
$V = \frac{50}{10} = 5$

V = u + at

5 = 0 + a × 20

a = 1/4, F = 20 × 1/4 = 5 N

8. A square loop is slowly pulled out from uniform magnetic field directed perpendicular to the plane of loop in 0.1 sec. If area of loop is 25 m^2 and magnetic field is 40 T find work done, if resistance of loop is 10Ω



(1) 10^4N (2) 10^6N (3) 10^2N (4) 10^7N

Ans. **(2)**

Sol. $V = \frac{5}{0.1} = 50$, $F = Bi\ell$

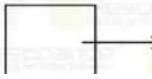
$F = B\frac{B\ell v}{R}\ell = \frac{B^2\ell^2 v}{R} \Rightarrow W = F\ell = \left(\frac{B^2\ell^2 v}{R}\right)\ell = \frac{1600 \times 125 \times 50}{10} = 10^6$ N

9. A block having base area 25m^2 is slowly pulled with constant velocity v on an oil layer made over a horizontal surface. If thickness of oil layer is 0.1 mm and applied horizontal force is 0.1 N and coefficient of viscosity $\eta = 6 \times 10^{-5}$ Deca poise, find the value of v.

(1) $\frac{1}{200}$ m/s (2) $\frac{1}{120}$ m/s (3) $\frac{1}{150}$ m/s (4) $\frac{1}{140}$ m/s

Ans. **(3)**

Sol.

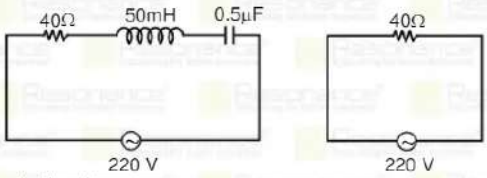


F_V

$$F = F_V = \eta A \frac{v}{D}$$

$$V = \frac{FD}{\eta A} = \frac{0.1 \times 0.1 \times 10^{-3}}{6 \times 10^{-5} \times 25} = \frac{1}{150} m/s$$

10. Current flowing in first circuit is I_1 and in second circuit is I_2. Choose the correct option if frequency is adjusted.



(1) I_1 is always greater then I_2.
(2) I_1 is never greater then I_2.
(3) I_1 is always equal to I_2.
(4) I_1 is equal to I_2 at resonance frequency of first circuit

Ans. **(4)**

Sol. At resonance frequency

$$I_1 = I_2 = \frac{220}{40}$$

11. If maximum amplitude of amplitude modulated wave is 14 volt and minimum amplitude is 6 volt then find the modulation index.

(1) 0.1 (2) 0.4 (3) 0.8 (4) 0.16

Ans. **(2)**

Sol. $$\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}} = \frac{14-6}{14+6} = \frac{8}{20} = 0.4$$

12. A particle in simple harmonic motion is acted upon by a force $F = -25x$ in S.I. units if mass of particle is 250 gm and maximum speed is 4 m/s find amplitude of S.H.M :

(1) 10 cm (2) 20 cm (3) 30 cm (4) 40 cm

Ans. **(4)**

Sol. $K = 25$, $\omega = \sqrt{\frac{25}{0.25}} = 10$ red/sec

$V_{max} = A\omega$

$4 = A \times 10$

$A = 0.4$ m $= 40$ cm

13. Find the ratio of De-Broglie wavelength of an alpha particle and a proton if they are accelerated from rest through same potential difference

(1) $\frac{1}{\sqrt{2}}$ (2) $\frac{2}{\sqrt{2}}$ (3) $\frac{1}{2\sqrt{3}}$ (4) $\frac{1}{2\sqrt{2}}$

Ans. **(4)**

Sol. $$\lambda = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2mqv}}$$

$$\lambda\alpha = \frac{h}{\sqrt{2 \times 4m \times 2eV}}, \lambda P = \frac{h}{\sqrt{2 \times m \times eV}}$$

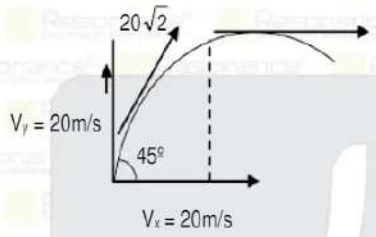
$$\frac{\lambda_\alpha}{\lambda_P} = \frac{\frac{h}{\sqrt{2 \times 4m \times 2eV}}}{\frac{h}{\sqrt{2 \times m \times eV}}} = \frac{1}{2\sqrt{2}}$$

14. A projectile of mass 1 kg is thrown at an angle of 45º with initial velocity $20\sqrt{2}$ m/s. If magnitude of angular momentum of particle about point of projection after 2 second is K then find the value of $\sqrt{k}$

(1) 20 (2) 30 (3) 10 (4) 40

Ans. **(1)**

Sol.



$\vec{v} = 20\hat{i} + (20 - 10 \times 2)\hat{j}$

$\vec{v} = 20\hat{i}$ → It means at maximum height

$$H_{max} = \frac{(u\sin\theta)^2}{2g} = \frac{(20)^2}{2\times10} = 20 \text{ m}$$

Angular momentum = momentum × $r_\perp$

$1 \times 20 \times 20$

$k = 400$

$[\sqrt{k} = 20]$ Ans.

15. Consider four situation:

(I) A man pulls a bucket out of a well after filling it with water work then done by man on bucket is positive.

(II) work done by gravity in above situation is negative.

(III) A block is slowly pulled on a rough horizontal surface by applying an external force then work done by force is positive

(IV) A bob is oscillating in air and it stops after some time due to air resistance then work done by air resistance is negative

(1) All four are true (2) only I & II are true

(3) only III and IV are true (4) only I , II, III are true

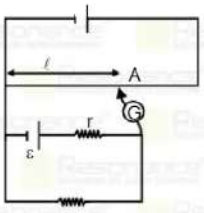
Ans. **(1)**

16. A potentiometer wire of primary circuit is connected to a battery of internal resistance r and EMF E. The Galvanometer shows no deflection at 200 cm when an external resistance of 5Ω is connected and galvanometer shows no deflection at 300 cm when an external resistance of 15Ω is connected across the cell, find the internal resistance of battery :

(1) 5Ω (2) 7Ω (3) 9Ω (4) 12Ω

Ans. **(1)**

Sol.



R

balancing the voltage at point A

$\varepsilon - ir = \frac{V}{L} \times \ell_1$

$\varepsilon - \frac{\varepsilon}{R+r} \times r = \frac{V}{L} \times \ell_1$

$\frac{\varepsilon R + \varepsilon r - \varepsilon r}{R+r} = \frac{V}{L} \times \ell$

$\frac{\varepsilon R}{R+r} = \frac{V}{L} \times \ell$

when $R = 5\Omega \quad \ell = 200$ cm

$\frac{\varepsilon \times 5}{5+r} = \frac{V}{L} \times 200 \quad .....(1)$

when $R = 15\Omega \quad \ell = 300$ cm

$\frac{\varepsilon \times 15}{15+r} = \frac{V}{L} \times 300 \quad ....(2)$

Eq. (2) / Eq. (1)

$\frac{15}{15+r} \times \frac{5+r}{5} = \frac{300}{200}$

$\frac{15+3r}{15+r} = \frac{3}{2} \Rightarrow 30 + 6r = 45 + 3r$

$3r = 15$

$r = 5\Omega$ Ans.

17. In Hydrogen atom, radius of first bohr orbit is 0.6 Å, find the radius of 3rd bohr orbit of He^+ :

(1) 1 Å (2) 2.7 Å (3) 5 Å (4) 7 Å

Ans. **(2)**

Sol. $r = \frac{n^2}{Z} a_0 = \frac{9}{2} \times 0.6 = 2.7$ Å

18. A wire of certain length is folded into 4 turns of circular loop and magnetic field at centres is 32T for some current flowing in it. If the same wire is folded into single loop having same current then find the magnetic field at the centre :

(1) T (2) 5T (3) 8T (4) 2T

Ans. **(4)**

Sol. $32 = \frac{4 \times \mu_0 I}{2\frac{\ell}{8\pi}} \quad ...(1)$

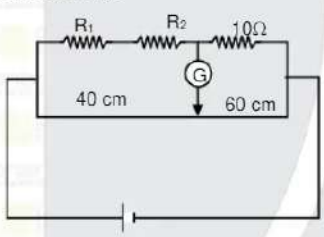
$B = 1 \times \frac{\mu_0 I}{2 \times \frac{\ell}{2\pi}} \quad ...(2)$

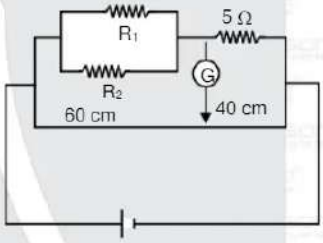
from equation (1) & (2)

$\frac{32}{B} = \frac{16}{1}$

$B = 2T$

19. In a meter bridge experiment balance length in two cases shown are 40 cm and 60 cm respectively find the product R_1R_2





(1) 2 (2) 4 (3) 6 (4) 8

Ans. **(1)**

Sol. $\frac{R_1}{R_2} = \frac{40}{60}$

10 60

$$\frac{\frac{R_1 \times R_2}{R_1 + R_2}}{5} = \frac{60}{40}$$

$$\frac{5R_1R_2}{R_1 + R_2} = \frac{60}{40}$$

$$\frac{5R_1R_2}{40/6} = \frac{60}{40}$$

$$5R_1R_2 = \frac{60}{6} = 10$$

$R_1 R_2 = 2$

20. Two radioactive substances of mass 320gm each and having atomic masses 16 and 32 have half-lives 1 day and 1/2 day respectively. After 2 days what will be ratio of their masses:

(1) 1 : 1 (2) 2 : 3 (3) 4 : 1 (4) 1 : 4

Ans. **(3)**

Sol. $$\frac{320\times\left(\frac{1}{2}\right)^2}{320\times\left(\frac{1}{2}\right)^4} = \frac{4}{1}$$

21. How to improve Resolving Power of compound microscope.

(1) By increasing Eyepiece diameter. (2) By increasing Eyepiece focal length.

(3) By decreasing Eyepiece focal length. (4) By increasing refractive index of length.

Ans. **(4)**

Sol. $R.P = \frac{2\mu \sin\theta}{\lambda}$

If $\mu \uparrow \rightarrow$ R.P $\uparrow$ses

22. The rms speed of an ideal gas molecules at 300 K is $\sqrt{\frac{a+5}{a}}$ times the average speed of gas molecules, then find the value of α

(1) 16 (2) 20 (3) 24 (4) 28

Ans. **(4)**

Sol. $V_{rms} = \sqrt{\frac{3RT}{m_0}}$, $V_{avg} = \sqrt{\frac{8}{\pi}\cdot\frac{RT}{m_0}}$

given

$V_{rms} = \sqrt{\frac{a+5}{a}}\, V_{avg}$

$$\sqrt{\frac{3RT}{m_0}} = \sqrt{\frac{a+5}{a}} \times \sqrt{\frac{8}{\pi}\cdot\frac{RT}{m_0}}$$

$$3 = \frac{a+5}{a}\cdot\frac{8}{\pi}$$

$$3 = \frac{a+5}{a}\,\frac{8}{\frac{22}{7}}$$

$$3 = \frac{a+5}{a}\times\frac{4\times7}{11}$$

$$3 = \frac{28(a+5)}{11a}$$

$33a = 28a + 140$

$a = 28$

23. A charge of 20C is taken from (1, 2) to origin in an electric field of $30\,\hat{i}\,\frac{N}{C}$. Find the work done against electric field:

(1) –1200J (2) 1200J (3) 600J (4) –600J

Ans. (3)

Sol. Work done = q × E × S; $\vec{E} = 30\,\hat{i}$

= 20 × (30 × 1)

= 600 J

24. A particle moves in a circle of radius R such that magnitude of tangential and centripetal acceleration are always equal in magnitude. If its initial speed is v_0 find time taken to rotate by 90° :

(1) $\frac{R}{2v_0}\left(1-e^{-\frac{\pi}{2}}\right)$ (2) $\frac{R}{v_0}\left(1-e^{-\frac{\pi}{2}}\right)$ (3) $\frac{2R}{v_0}\left(1-e^{-\frac{\pi}{2}}\right)$ (4) $\frac{R}{v_0}\left(1-e^{-\frac{3\pi}{2}}\right)$

Ans. (2)

Sol. $|a_c| = |a_t|$

$$\frac{v^2}{R} = \frac{dv}{dt}$$

$$\int_{v_0}^{v}\frac{dv}{v^2} = \frac{1}{R}\int_0^t dt$$

$$\frac{1}{v_0} - \frac{1}{v} = \frac{t}{R}$$

$$\frac{1}{v} = \frac{1}{v_0} - \frac{t}{R} \Rightarrow v = \frac{v_0 R}{R - v_0 t}$$

$$\frac{ds}{dt} = \frac{v_0 R}{R - v_0 t}$$

$$\int_0^{\pi R/2} dS = v_0 R\int_0^t \frac{dt}{R - v_0 t}$$

$$\frac{\pi R}{2} = \frac{v_0 R}{-v_0}\ln\left(\frac{R - v_0 t}{R - 0}\right)$$

$$\frac{\pi}{2} = \ln\left(\frac{R}{R - v_0 t}\right)$$

$$\frac{R}{R - v_0 t} = e^{\pi/2} \Rightarrow Re^{-\pi/2} = R - v_0 t$$

$$t = \frac{R}{v_0}\left(1-e^{-\frac{\pi}{2}}\right)$$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